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NUTRIENT CONTENT OF RURAL RUNOFF IN THE UPPER WABASH RIVER BASIN

FEDERAL WATER POLLUTION CONTROL ADMINISTRATION
EVANSVILLE, INDIANA

APRIL 1968

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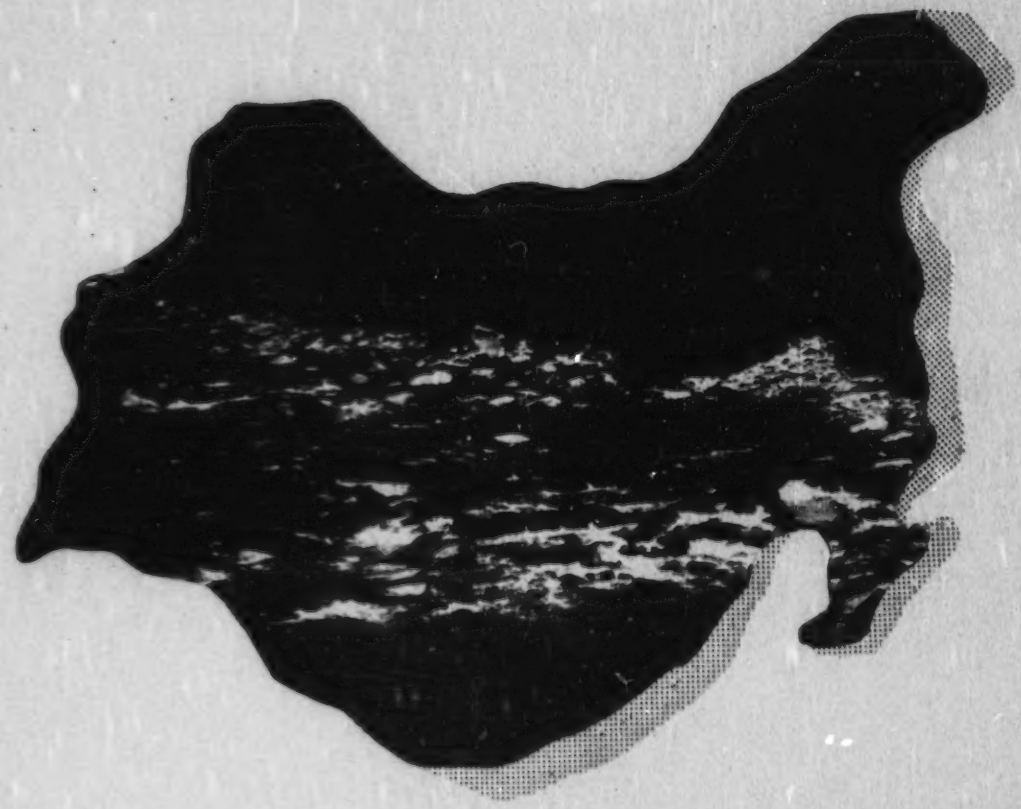

UNITED STATES DEPARTMENT OF THE INTERIOR
FEDERAL WATER POLLUTION CONTROL ADMINISTRATION
OHIO BASIN REGION
OHIO RIVER BASIN PROJECT
EVANSVILLE FIELD STATION, INDIANA

APRIL 1968

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Nutrient Content of Rural Runoff in the Upper Wabash River Basin

Work Document No. E4

This document has been prepared to record a specific water pollution control activity carried out to date in the furtherance of the water pollution control program being developed in the Ohio River Basin. The information contained herein will serve as a ready reference to aid in the planning and development of the program in the Basin, for appropriate in-service training of participating personnel, and facilitating program activities with other cooperating groups.

Questions or comments relative to this material should be directed to:

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UNITED STATES DEPARTMENT OF THE INTERIOR
FEDERAL WATER POLLUTION CONTROL ADMINISTRATION
OHIO BASIN REGION
OHIO RIVER BASIN PROJECT

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I. INTRODUCTION

1. Purpose

Nuisance algal blooms in Wabash River tributaries which receive only small amounts of municipal wastes prompted the Evansville Field Station to study runoff from rural land. The primary purpose of this study was to determine concentrations and amounts of soluble nitrogen and phosphorus and total nitrogen and phosphorus in runoff water from rural land and to ascertain whether these concentrations would be great enough to stimulate nuisance algal blooms. The data thus gathered will influence recommendations for the degree of waste treatment or of quality control measures in various stream reaches.

Authority

This document has been prepared in accordance with Section 3(a) of the Federal Water Pollution Control Act as amended (33 USC 466 et seq.).

II. SUMMARY AND CONCLUSIONS

1. Summary

Water samples were collected once each week during the 1967 water year from four small watersheds that represented three different soil associations in a rural area. Three stations on two streams were selected to coincide with U.S.G.S. gaging stations. These streams received municipal and industrial wastes as well as rural runoff. Flow data were obtained during the period of study so watershed runoff could be determined. Loading was determined from nutrient concentrations and flow data.

The following determinations were made: air temperature, water temperature, conductivity, field pH, laboratory pH, dissolved oxygen, chlorides, nitrate nitrogen, total Kjeldahl nitrogen, soluble phosphorus, and total phosphorus. From July 21 to September 29, 1967, additional samples were collected every two weeks and analyzed for pesticides.

2. Conclusions

Average concentrations of nitrate nitrogen and soluble phosphorus for the year were higher than those required to stimulate nuisance algal blooms in reservoirs (0.30 mg/l and 0.01 mg/l respectively)(6). (See Table 2.)

Concentrations and losses (stream loading in pounds) of nitrate nitrogen and soluble phosphorus were lower during the summer than for any other season. Concentrations generally exceeded the minimum levels necessary to stimulate nuisance algal blooms in reservoirs(6). (See Tables 3 and 4).

Concentrations and losses of nutrients were higher during higher stages of streams than during steady or base flows. (This difference is reflected in Tables 3 and 4).

Rural runoff entering the Mississinewa River, which also carried municipal and industrial wastes, exerted a diluting effect on nitrogen and phosphorus in the river. (Compare Pike Creek with Mississinewa River in Table 2.)

Different soils had no effect on nutrient concentrations in rural runoff. Average nitrogen and phosphorus concentration in runoff water varied more between identical soils than between different soils. (See Table 2.)

Runoff from rural land that is mostly used for farm crops can be expected to have nutrient concentrations higher than those required to stimulate nuisance algal blooms in reservoirs(6). Investigations in the States of Illinois, Indiana, Mississippi, Ohio, Washington, and Wisconsin show results with respect to phosphorus similar to those in this study(4).

Pesticide concentration in runoff water was negligible during the period when samples were collected and analyzed for this pollutant.

III. DESIGN OF THE STUDY

1. Description of the study areas

Except for size of drainage area, the watersheds of Pike and Rock Creeks are almost identical. The principal soils are Blount silt loam and Pewamo silty clay loam. Morley silt loam is a minor soil. These nearly level to sloping, moderately to very highly productive, slowly permeable soils developed on limy clay loam till. Blount silt loam is light colored, level to gently sloping, and somewhat poorly drained. Morley silt loam is light colored, sloping, and moderately well drained. Pewamo silty clay loam is dark colored, depressional, very poorly drained, and high in moisture supplying capacity, fertility, and organic matter. Pewamo and Blount soils are mostly tile drained. Blount and Morley soils are moderate in moisture supplying capacity, fertility, and organic matter. Erosion is a hazard on slopes. Grain and livestock farming predominates.

Principal soils of the Blue River watershed are Morley and Blount silt loams. Pewamo silty clay loam is a minor soil. These nearly level to moderately steep, moderately productive, slowly permeable soils developed on limy clay loam till. Morley silt loam is light colored, sloping to moderately steep, and moderately well drained. Blount silt loam is light colored, level to gently sloping, and somewhat poorly drained. Morley and Blount soils are moderate in moisture supplying capacity, fertility, and organic matter. Pewamo silty clay loam is dark colored, depressional, very poorly drained, and high in moisture supplying

capacity, fertility, and organic matter. Blount and Pewamo soils are mostly tile drained. Erosion is a hazard on slopes. Grain and livestock farming predominates.

Mud Creek watershed contains a variety of moderately permeable to permeable, nearly level to sloping, low to high in moisture supplying capacity, moderately to very highly productive soils. The principal soils are Brookston, Crosby, and Miami loams which developed on limy loam till and Nyona silt loam and Maumee loam and fine sandy loam which developed on limy sand and silt(1). Miami loam is light colored, sloping, and subject to erosion. Crosby loam is light colored, level to gently sloping, somewhat poorly drained, and is mostly tile drained. Brookston, Nyona, and Maumee soils are nearly level, dark colored, very poorly drained, and are mostly tile drained. Grain and livestock farming predominates.

Percent of farms in cropland in Blue River and Rock, Mud, and Pike Creek Watersheds ranged from 84.6 to 89.3 (2). The land use pattern is similar to that of a large part of the Wabash River Basin. In the southern part the percent of farms in cropland is lower.

The Mississinewa River watershed is similar in all respects to Rock and Pike Creek watersheds.

The Eel River watershed is similar to Blue River and Mud Creek watersheds, except that a significant amount of permeable Fox soils occur in the Eel River valley. About one-half of the soils are moderately

permeable to permeable Miami, Crosby, Brookston, Nyona, Maumee, and Fox soils, and the remainder are slowly permeable Morley, Blount, and Pewamo soils. Figure 1 shows location of study areas.

2. Hydrology*

For purpose of this study, seven gaging stations were used. Three of these were stations normally operated by the U. S. Geological Survey and four were temporary stations on study streams.

The U.S.G.S. stream-gaging stations, in addition to being used as sampling stations, were used as controls in determining total stream flow at the other four locations. Discharge hydrographs, based on preliminary data from the U. S. Geological Survey, are shown in Figures 2, 3, and 4 for the three permanent stations.

Runoff from the permanent stations was determined from preliminary mean daily discharges computed by the U. S. Geological Survey. At temporary stations, stream flows at times of sampling were determined from reference readings made by the sampler and from stage-discharge rating curves based on 12 discharge measurements made at each station during the study period. Volume determinations (inches of runoff from the respective drainage areas) were based on correlations with mean daily discharges at the permanent stations.

Water year 1967 was more or less a normal year in the Upper Wabash Basin. It was slightly wetter than average, having one flood in December 1966 and several moderate rises in stream flows. It did not have an extremely dry period and none of the streams fell to the 7 day once-in-10-year low flow level.

*By D. W. Hook, Hydraulic Engineer, Evansville Field Station

Since flows at the temporary stations were measured only for this study, the intermittent records are inadequate for determination of recurrence intervals for flows obtained during the water year. Based on discharge measurements made at the temporary stations during the study period and preliminary records of flows at the permanent stations, it is believed that flows at the temporary stations also may be slightly higher than average.

Total runoff in inches for each month of the study and for the 1967 water year are shown for the seven stations on Table 1.

3. Approach

Some sources have indicated that concentrations of nitrogen and phosphorus in runoff from rural land would be related to kind of soil. Accordingly, four small watersheds 20.5 to 92 sq. mi. in size were selected in which there were no industrial wastes, no large livestock feed lots, and only a very few small villages. The percent of farms in cropland ranged only from 84.6 percent to 89.3 percent(2). The streams were perennial, with low flows greater than 0.3 cfs.

The major soils in Pike and Rock Creek watersheds are slowly permeable Blount silt loam and Pewamo silty clay loam. Morley silt loam is a minor soil. The major soils in Blue River watershed are slowly permeable Morley and Blount silt loams. Pewamo silty clay loam is a minor soil. The major soils in Mud Creek watershed are moderately permeable Brookston, Crosby, and Miami loams and permeable Nyona silt loam and Maumee loam and fine sandy loam.

Table 1. Monthly and Annual Runoff for the 1967 Water Year - in Inches

Station	D.A. sq mi	1966 Oct.	Nov.	Dec.	1967 Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sep.	Total	Avg. for Period of Record
EEL-3 Eel River nr Logansport	791	0.16	0.92	4.29	0.65	1.57	2.66	1.78	1.56	0.43	0.31	0.23	0.18	14.74	11.7
MIS-5 Mississinewa R. at Marion	677	0.07	0.48	4.05	0.78	1.12	3.18	1.13	1.62	0.21	.13	0.08	0.07	12.92	12.5
MIS-23 Mississinewa R. nr Eaton	304	0.05	0.89	4.15	0.97	1.31	4.22	1.45	1.80	0.22	0.12	0.03	0.02	15.23	11.7
ARO-2* Pike Creek nr Wheeling	21.5	0.07	0.48	4.05	0.78	1.12	3.18	1.13	1.62	0.21	0.13	0.08	0.07	12.92	
ARO-4* Rock Creek nr Markle	92	0.01	0.41	3.40	0.23	0.90	1.80	1.04	0.97	0.12	0.07	0.03	0.01	8.99	
ARO-5* Blue River nr Columbia City	60	0.07	0.84	4.21	0.41	1.25	3.26	1.43	1.21	0.25	0.31	0.11	0.08	13.43	
ARO-6* Mud Creek nr Bruce Lake	69	0.06	0.93	4.09	0.63	1.57	2.63	1.77	1.57	0.40	0.25	0.15	0.10	14.15	

* Based on comparisons with preliminary USGS data from nearby gaging stations.

Three stations on two streams were selected to coincide with U.S.G.S. gaging stations. In addition to rural runoff, these streams received industrial/municipal wastes. Two of these stations were on the Mississinewa River; the third was on the Eel River.

4. Chemistry

(1) Methods

a. Sampling

All streams were sampled weekly at, or as near as possible, midpoint of the stream and at the same location as stream stage measurements were made. Water samples could not be collected during storm periods at intervals necessary to define the precise nutrient level during rising stream stages or at peak storm runoff.

Hydrographs of mean daily discharge shown in Figures 2, 3, and 4 also show dates of sampling. This shows whether the stream was rising, falling, or steady at time of sampling.

b. Analytical Methods

Chemical methods were selected from "Standard Methods,"(3). Minor modifications were made in nitrate nitrogen, chloride, and phosphorus procedures to enhance the analyses.

The following parameters were determined:

Parameter	Method
Chloride	Mecuric nitrate (3)
Nitrate Nitrogen	Modified Brucine (3)
Total Kjeldahl Nitrogen	Micro-Kjeldahl digestion plus Distillation/Nesslerization (3)
Total soluble Phosphorus	Stannous Chloride (3) Persulfate modification (3)
Total Phosphorus	Stannous Chloride (3) Persulfate modification (3)
pH	Electrometric (3)

All analytical determinations except for pesticides were made at the laboratory of the Evansville Field Station, Ohio River Basin Project.

Pesticide analyses were made in the laboratory of Division of Pollution Surveillance, FWPCA, Cincinnati, Ohio.

IV. RESULTS

Average nitrate nitrogen concentration in rural runoff ranged from 1.95 mg/l in Pike Creek to 2.48 mg/l in Rock Creek; total Kjeldahl nitrogen ranged from 0.99 mg/l in Pike Creek to 1.42 mg/l in Mud Creek. Average soluble phosphorus concentration ranged from 0.044 mg/l in Blue River to 0.076 mg/l in Rock Creek; total phosphorus ranged from 0.087 mg/l in Blue River to 0.207 mg/l in Rock Creek. Average annual maximum and minimum values of the parameters studied are shown in Table 2.

Average nitrate nitrogen concentrations in rural runoff during the summer ranged from 0.36 mg/l in Pike Creek to 0.58 mg/l in Rock Creek; total Kjeldahl nitrogen ranged from 0.65 mg/l in Pike Creek to 0.98 mg/l in Rock Creek. Average soluble phosphorus concentration ranged from 0.009 mg/l in Blue River to 0.058 mg/l in Rock Creek; total phosphorus ranged from 0.024 mg/l in Blue River to 0.103 mg/l in Rock Creek. Average seasonal concentrations of nitrogen and phosphorus in runoff are shown in Table 3.

Total seasonal amounts of nitrogen and phosphorus lost in runoff are shown in Table 4.

Pounds of nitrogen used per acre of cropland during the study ranged from 38.64 in Blue River watershed to 44.26 in Pike Creek watershed. Pounds of nitrate nitrogen lost per acre of cropland ranged from 7.84 in Rock Creek watershed to 11.41 in Blue River watershed. Pounds

Table 2. Average, Maximum and Minimum Values of Parameters Studied

		Temp. °C Air	Temp. °C Water	Conductivity †	Field pH	Lab. pH	mg/l D.O.	mg/l Cl	mg/l NO_3N	mg/l Total Kjeldahl N	mg/l Sol. P.	mg/l Total P.	
	1	Mississinewa River at Marion, Indiana											
Max.		24	22	1000	8.5	8.3	12.9	120.0	8.8	4.8	0.79	1.98	
Min.		-3	-1	280	7.0	6.3	3.4	8.0	0.1	<0.2	0.01	0.07	
Avg.		11*	12*	730	7.9	7.6	9.1	44.2	2.24	1.46	0.269	0.467	
	2	Pike Creek near Wheeling, Indiana											87.07% Cropland
Max.		24	20	700	8.3	8.2	13.0	93.0	7.2	2.0	0.24	0.99	Blount-Pewamo
Min.		-5	0	420	7.1	6.4	4.1	5.0	0.0	0.3	0.003	0.01	soils
Avg.		10*	10*	637	7.7	7.8	9.1	23.4	1.95	0.99	0.05	0.12	
	3	Mississinewa River near Eaton, Indiana											
Max.		26	20	850	8.3	8.2	13.0	99.2	8.8	12.2	0.38	0.96	
Min.		-5	-1	360	7.2	6.4	3.4	8.1	0.2	<0.2	0.009	0.058	
Avg.		10*	11*	693	7.8	7.7	8.5	31.3	2.21	1.51	0.112	0.222	
	4	Rock Creek at Indiana Highway No. 3											89.33% Cropland
Max.		28	20	780	8.1	8.3	12.5	86.6	7.8	2.1	0.19	1.20	Blount-Pewamo
Min.		-10	-2	240	6.9	6.3	2.3	8.0	0.0	0.3	0.014	0.03	soils
Avg.		9*	10*	598	7.6	7.7	8.0	23.0	2.48	1.18	0.076	0.207	
	5	Blue River near Columbia City, Indiana											84.64% Cropland
Max.		16	15	950	7.8	8.1	11.9	70.0	16.2	2.7	0.17	0.86	Morley-Blount
Min.		-10	0	300	6.7	6.2	5.1	6.0	0.0	0.2	0.002	0.013	soils
Avg.		7*	10*	702	7.3	7.4	9.0	16.5	2.00	1.19	0.044	0.087	
	6	Mud Creek near Bruce Lake, Indiana											89.12% Cropland
Max.		32	22	840	8.0	8.6	13.4	88.0	16.0	3.7	0.30	0.99	Brookston-
Min.		-6	0	300	7.0	6.2	5.8	9.0	0.0	0.3	0.006	0.025	Crosby-Miami
Avg.		11*	10*	692	7.6	7.7	9.4	18.8	2.06	1.42	0.056	0.101	Nyona-Maumee
	7	Eel River near Logansport, Indiana											soils
Max.		24	20	820	8.1	8.2	16.0	62.7	16.0	3.3	0.22	1.25	
Min.		-6	-2	275	7.1	6.7	5.3	8.5	0.0	0.3	0.024	0.03	
Avg.		9*	11*	634	7.7	7.7	9.4	21.0	2.66	1.27	0.072	0.164	

* Median value
† Micromhos per centimeter

Table 3. Average Seasonal Concentrations of Nitrogen and Phosphorus in Runoff

		mg/l			
		NO_3N	Total Kjeldahl N	Sol. P.	Total P.
Pike Creek Ave.	Oct.-Dec.	1.67	1.24	0.094	0.14
	Jan.-Mar.	3.47	1.30	0.091	0.193
	Apr.-June	2.63	0.99	0.028	0.12
	July-Sep.	0.36	0.65	0.019	0.054
Rock Creek Ave.	Oct.-Dec.	2.37	1.37	0.113	0.25
	Jan.-Mar.	3.66	1.44	0.079	0.28
	Apr.-June	3.67	1.07	0.062	0.23
	July-Sep.	0.58	0.98	0.058	0.103
Blue River Ave.	Oct.-Dec.	3.66	1.65	0.085	0.16
	Jan.-Mar.	2.97	1.86	0.064	0.11
	Apr.-June	1.64	1.03	0.031	0.069
	July-Sep.	0.41	0.62	0.009	0.024
Mud Creek Ave.	Oct.-Dec.	3.40	1.92	0.086	0.11
	Jan.-Mar.	2.22	1.88	0.10	0.19
	Apr.-June	2.44	1.08	0.027	0.062
	July-Sep.	0.44	0.97	0.021	0.056
Mississinewa R. at Marion Ave.	Oct.-Dec.	3.18	1.40	0.355	0.582
	Jan.-Mar.	3.52	1.84	0.162	0.396
	Apr.-June	2.21	1.24	0.169	0.405
	July-Sep.	0.50	1.45	0.386	0.491
Mississinewa R. near Eaton Ave.	Oct.-Dec.	3.21	1.19	0.174	0.260
	Jan.-Mar.	3.29	2.76	0.082	0.247
	Apr.-June	2.41	0.94	0.091	0.202
	July-Sep.	0.54	1.38	0.011	0.202
Eel River near Logansport Ave.	Oct.-Dec.	3.88	1.58	0.089	0.245
	Jan.-Mar.	3.71	1.72	0.085	0.181
	Apr.-June	2.64	1.15	0.067	0.117
	July-Sep.	0.82	0.70	0.059	0.088

Table 4. Total Seasonal Amounts of Nitrogen and Phosphorus in Runoff

	Inches Runoff		Pounds*			
			NO_3N	Total Kjeldahl N	Sol. P.	Total P.
Pike Creek	4.60	Oct.-Dec.	38,629	20,215	1,290	1,561
	5.08	Jan.-Mar.	62,163	19,324	1,570	3,180
	2.96	Apr.-June	30,940	10,058	331	1,263
	0.28	July-Sep.	331	592	15	48
Rock Creek	3.82	Oct.-Dec.	142,338	79,321	4,246	17,958
	2.93	Jan.-Mar.	161,393	56,178	32,951	12,046
	2.13	Apr.-June	107,482	34,025	1,887	7,853
	0.11	July-Sep.	1,373	1,568	83	141
Blue River	5.12	Oct.-Dec.	147,308	81,804	3,570	11,221
	4.92	Jan.-Mar.	172,515	90,256	2,757	4,893
	2.89	Apr.-June	49,000	29,804	817	2,312
	0.50	July-Sep.	2,118	3,234	42	106
Mud Creek	5.08	Oct.-Dec.	164,759	98,883	3,888	5,636
	4.83	Jan.-Mar.	117,401	94,293	5,318	11,091
	3.74	Apr.-June	97,604	44,275	1,150	2,603
	0.50	July-Sep.	2,596	5,144	104	275
Mississinewa R. at Marion	4.60	Oct.-Dec.	1,499,179	661,741	139,246	277,280
	5.08	Jan.-Mar.	2,043,464	830,794	84,489	217,049
	2.96	Apr.-June	842,968	410,824	40,269	122,802
	0.28	July-Sep.	21,070	38,106	9,379	12,868
Mississinewa R. near Eaton	5.09	Oct.-Dec.	735,749	306,085	27,385	62,543
	6.50	Jan.-Mar.	1,049,309	1,032,572	25,358	70,005
	3.47	Apr.-June	433,370	174,016	10,603	26,523
	0.17	July-Sep.	7,853	9,591	854	1,457
Eel River near Logansport	5.37	Oct.-Dec.	2,048,217	1,076,184	48,141	214,700
	4.88	Jan.-Mar.	2,289,705	1,063,048	50,990	122,992
	3.77	Apr.-June	1,224,455	551,938	28,386	99,293
	0.72	July-Sep.	71,905	74,245	4,807	7,243

* Nutrient loading = C x R x A x K
C - concentration mg/l
R - inches runoff
A - drainage area in sq mi
K - converts one mg/l into pounds of nutrients for one inch of runoff per sq mi

of total Kjeldahl nitrogen lost per acre of cropland ranged from 3.25 in Rock Creek watershed to 6.31 in Blue River watershed. Pounds of phosphorus used per acre of cropland during the study ranged from 14.85 in Blue River watershed to 16.79 in Mud Creek watershed. Pounds of soluble phosphorus lost per acre of cropland ranged from 0.18 in Rock Creek watershed to 0.29 in Mud Creek watershed. Pounds of total phosphorus lost per acre of cropland ranged from 0.50 for Mud Creek watershed to 0.72 for Rock Creek watershed. Land use, fertilizer and runoff data are shown in Table 5.

Nutrients from towns and industries are shown in Table 6. Nutrients lost from the watershed minus nutrients lost from cropland in the watershed equals nutrients assumed to be contributed by towns and industry.

Pike and Rock Creek watersheds have soils and land use similar to the Mississinewa River watershed. Acres of cropland in the Mississinewa River watershed times the average amount of nutrients lost per acre from cropland in Pike and Rock Creek watersheds is assumed to equal the pounds of nutrients lost from cropland in the Mississinewa River watershed. Blue River and Mud Creek watersheds were used in similar calculations for the Eel River watershed.

Amount of nutrients from towns and industry are of interest but are not pertinent to the object of the study.

Population equivalent of nutrients in runoff is shown in Table 7.

Samples of rural runoff were analyzed for pesticides during the summer. Concentrations were very low. Table 8 shows pesticide concentration in rural runoff.

Table 5. Land Use, Fertilizer and Runoff Data

	Pike Creek	Rock Creek	Blue River	Mud Creek
Size of Watershed - sq mi	21.5	92	60	69
Size of Watershed - acres	13,760	58,880	38,400	44,160
Percent cropland	87.07	89.33	84.64	89.12
Acres in cropland	11,981	52,598	32,502	39,355
Percent pasture	5.48	2.83	4.07	3.38
Acres in pasture	754	1,666	1,563	1,493
Percent woodland	7.45	7.84	11.29	7.50
Acres in woodland	1,025	4,616	4,335	3,312
Lbs N used per acre cropland-Fall 1966, Spring 1967	44.26	43.11	38.64	41.65
Lbs N used on cropland - Fall 1966, Spring 1967	530,300	2,267,500	1,255,900	1,639,100
Lbs NO_3N lost from cropland	132,100	412,600	371,000	382,400
Lbs NO_3N lost per acre of cropland	11.02	7.84	11.41	9.72
Lbs total Kjeldahl N lost from cropland	50,200	171,100	205,100	242,600
Lbs total Kjeldahl N lost per acre of cropland	4.19	3.25	6.31	6.16
Lbs P used per acre cropland-Fall 1966, Spring 1967	16.73	15.71	14.85	16.79
Lbs P used on cropland-Fall 1966, Spring 1967	200,400	826,300	482,700	660,800
Lbs sol. P lost from cropland	3,200	9,500	7,200	11,300
Lbs sol. P lost per acre of cropland	0.27	0.18	0.22	0.29
Lbs total P lost from cropland	6,100	38,000	18,500	19,600
Lbs total P lost per acre of cropland	0.51	0.72	0.57	0.50

Note - Losses are computed on the basis of cropland only, not taking into account the rather insignificant contributions of non-cropland areas.

Table 6. Nutrients from Towns and Industries

	Mississinewa River at Marion	Mississinewa River Near Eaton	Eel River Near Logansport
Size of Watershed - sq mi	677	304	791
Size of Watershed - acres	433,280	194,560	506,240
Percent cropland (est.)	85	86	85
Acres cropland	368,288	167,322	430,304
Lbs sol. P lost from watershed	273,000	64,000	132,000
Lbs sol. P lost per acre of cropland	0.23*	0.23*	0.26**
Lbs sol. P lost from cropland	85,000	38,000	112,000
Lbs total P lost from watershed	630,000	161,000	444,000
Lbs total P lost per acre of cropland	0.62*	0.62*	0.55**
Lbs total P lost from cropland	228,000	104,000	237,000
Lbs NO_3N lost from watershed	4,407,000	2,226,000	5,634,000
Lbs NO_3N lost per acre cropland	9.43†	9.43†	10.57††
Lbs NO_3N lost from cropland	3,473,000	1,578,000	4,548,000
Lbs total Kjeldahl N lost from watershed	1,941,000	1,522,000	2,765,000
Lbs total Kjeldahl N lost per acre cropland	3.72†	3.72†	5.16††
Lbs total Kjeldahl N lost from cropland	1,370,000	622,000	2,220,000
Lbs sol. P from towns and industry	187,000	26,000	20,000
Lbs total P from towns and industry	402,000	57,000	208,000
Lbs NO_3N from towns and industry	934,000	648,000	1,086,000
Lbs total Kjeldahl N from towns and industry	571,000	900,000	545,000

* Average P of Pike and Rock Creeks
** Average P of Blue River and Mud Creek
† Average N of Pike and Rock Creeks
†† Average N of Blue River and Mud Creek

Table 7. Population Equivalent of Nutrients in Runoff

Watershed	D. A. in sq mi	Lbs Total N	Lbs Total P	Pop Equiv N	Pop Equiv N/sq mi	Pop Equiv P	Pop Equiv P/sq mi
Pike Creek	21.5	182,300	6,100	8,893	414	1,649	77
Rock Creek	92	583,700	38,000	28,473	309	10,270	112
Blue River	60	576,100	18,500	28,102	468	5,000	83
Mud Creek	69	625,000	19,600	30,488	442	5,297	77
Mississinewa River at Marion	677	5,414,000	630,000	264,098	390	170,270	252
Mississinewa River near Eaton	304	3,100,000	161,000	151,220	497	43,514	143
Eel River near Logansport	791	7,313,000	444,000	356,732	451	120,000	152

20.5 lb N/yr/capita in effluent

3.7 lb P/yr/capita in effluent

Weinberger & Stephan, USDI, FWPCA, Advanced Waste Treatment. 1967

Table 8. Pesticide Concentration in Rural Runoff

Stream	Location	Date 1967	Time	Lab No.	µg/l	
					Chlordane	Dieldrin
Pike Creek	Wheeling, Ind.	7/21	0745	9802	0.36	ND
		8/5	0650	9809	ND	ND
		8/18	0755	9810	ND	ND
		9/1	0740	9815	ND	ND
		9/15	0755	9819	ND	ND
		9/29	0850	9977	ND	ND
Rock Creek	Ind. Highway #3	7/21	0720	9803	0.06	ND
		8/5	0540	9808	ND	ND
		8/18	0615	9811	0.08	0.02
		9/1	0605	9816	0.09	0.03
		9/15	0630	9820	ND	ND
		9/29	0700	9974	ND	ND
Blue River	Columbia City, Ind.	7/21	0510	9804	ND	ND
		8/5	0450	9806	0.16	ND
		8/18	0515	9812	ND	ND
		9/1	0515	9817	ND	ND
		9/15	0520	9821	ND	ND
		9/29	0655	9976	ND	ND
Mud Creek	Ind. Highway #14	7/21	1050	9805	ND	ND
		8/4	1015	9807	0.25	0.08
		8/18	1100	9813	ND	ND
		9/1	1040	9814	P	P
		9/15	1430	9822	0.11	0.06
		9/28	1410	9975	ND	ND

Footnotes:
ND - Not Detected
P - Presumptive

V. APPLICATION AND RECOMMENDATIONS

Application

The results of this study show that nutrient concentrations of nitrogen and phosphorus greatly in excess of those required to stimulate nuisance algal blooms in reservoirs can be expected in runoff from land that is mostly used for producing farm crops. These results are applicable to all areas of similar land use in the Ohio River Basin. They cannot be applied to areas that are primarily forest. (4)(5)

Sawyer reports that concentrations in lakes in excess of 0.01 mg/l of inorganic phosphorus and 0.30 mg/l of inorganic nitrogen at the time of spring overturn can be expected to produce algal blooms of such density as to cause nuisance. This conclusion was reached after analyzing data from 17 lakes in southern Wisconsin(6).

Recommendations

All land in the Ohio River Basin should be put to its best use and the most feasible soil conservation practices applied as quickly as possible.[A] This will reduce the amount of nutrients, particularly phosphorus, in streams as well as silt pollution and any probable pesticide pollution.

VI. REFERENCES

(1) Roger, O. C. and others, Soil Survey Fulton County, Indiana. U. S. Department of Agriculture in cooperation with the Purdue University Agricultural Experiment Station. August 1946.

(2) Census of Agriculture, Indiana - 1964.

(3) American Public Health Association, Inc., Standard Methods for the Examination of Water and Wastewaters, APHA - AWWA - WPCF. 12th Edition. New York, N.Y. 1965.

(4) Mackenthun, Kenneth M., and Ingram, William Marcus, Biologically Associated Problems in Freshwater Environments. U. S. Department of the Interior, Federal Water Pollution Control Administration. July 1967, p. 110 and 111.

(5) Water Resource Data North Carolina. Part 2 - Water Quality Records. 1965, p. 186.

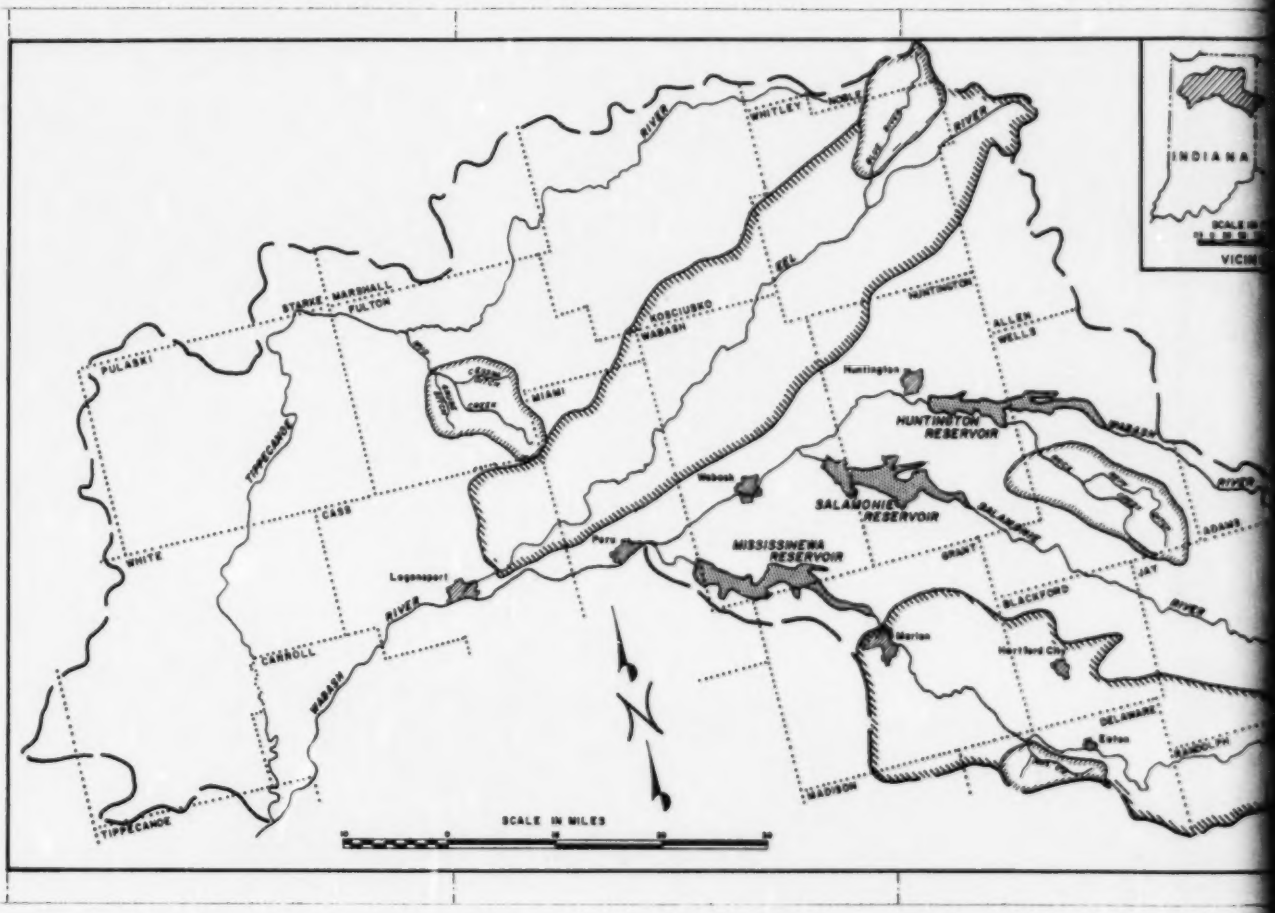
(6) "Some New Aspects of Phosphates in Relation to Lake Fertilization", Sawyer, C. N., Sewage and Industrial Wastes, vol. 24, No. 6, p. 768-776. 1952.

Other References

A - Weidner, R. B., Christianson, A. G., Weibel, S. R. and Robeck, G. C., Rural Runoff as a Factor in Stream Pollution. U. S. Department of the Interior, Federal Water Pollution Control Administration. January 1968.

B - Miller, William E. and Tash, Jerry C., Interim Report Upper Klamath Lake Studies Oregon, Publication No. WP-20-8, U. S. Department of the Interior, Federal Water Pollution Control Administration. September 1967.

APPENDIX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Huntington
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TIPPECANOE
CASS
Wabash
SALAMONIE RESERVOIR
WHITE
Peru
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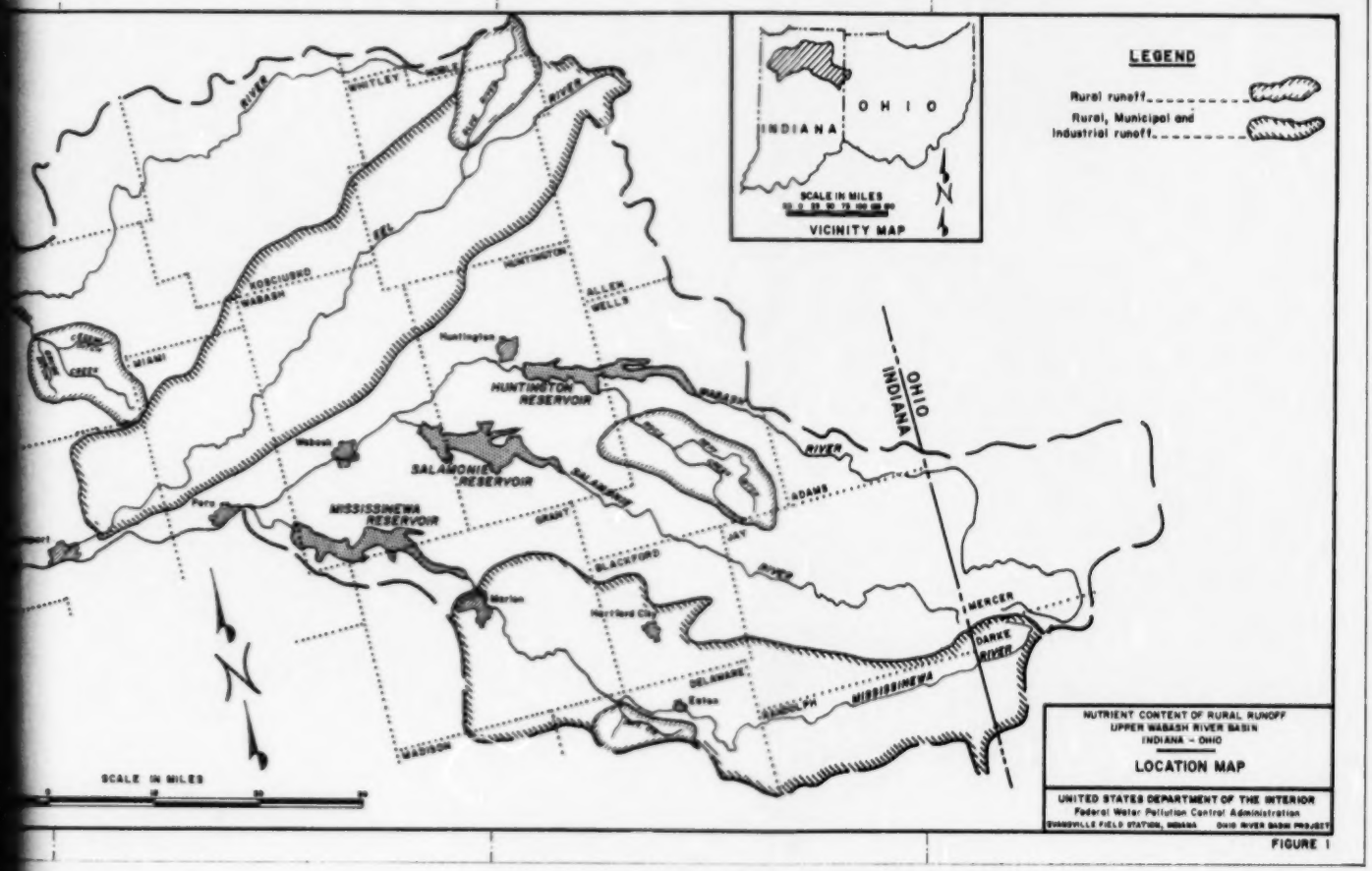
LEGEND
Rural runoff
Rural, Municipal and Industrial runoff
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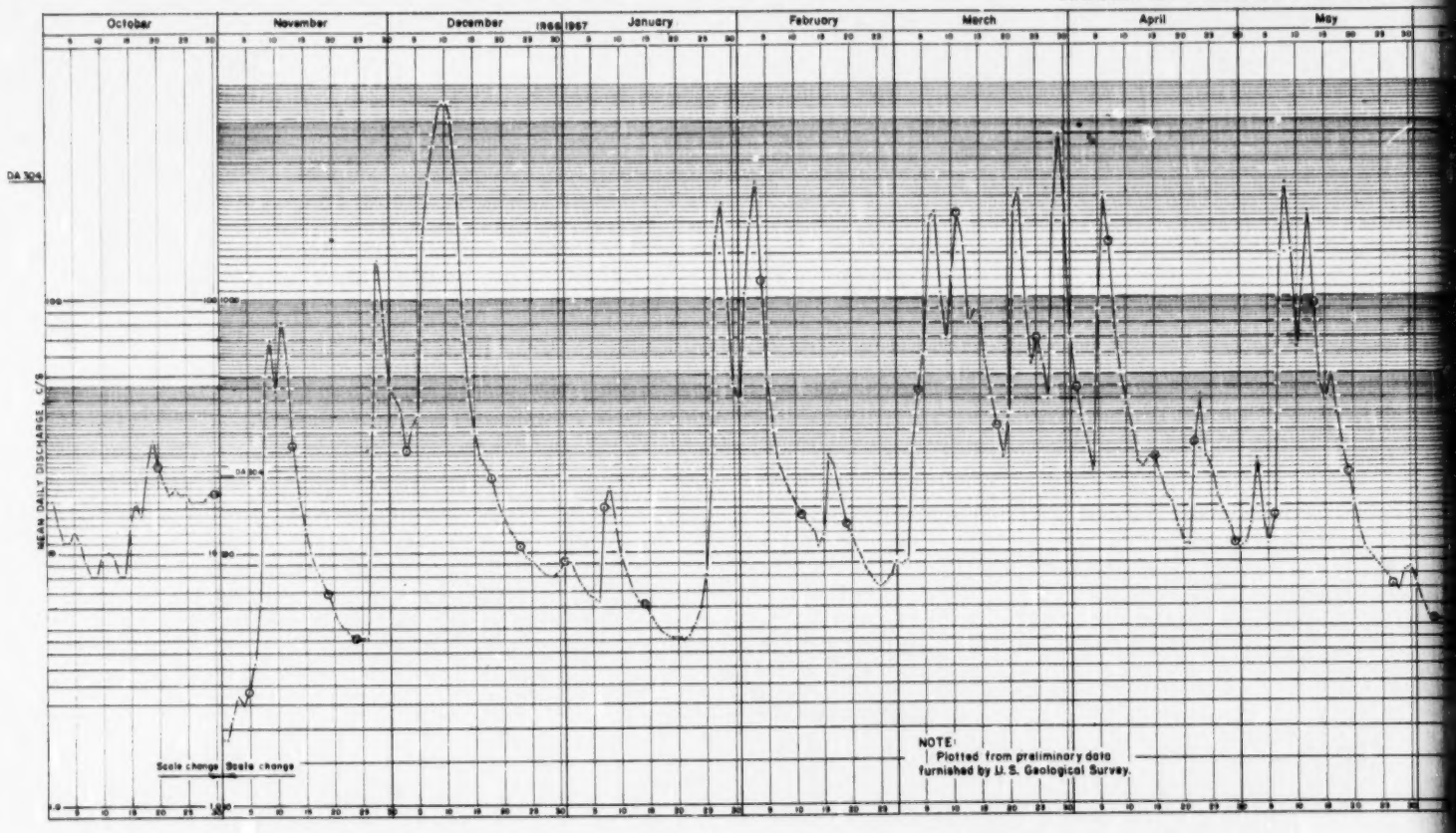
OHIO
SCALE IN MILES
VICINITY MAP
WHITLEY
KOSCIUSKO
WABASH
HUNTINGTON
ALLEN
WELLS
MIAMI
HUNTINGTON RESERVOIR
SALAMONIE RESERVOIR
MISSISSINEWA RESERVOIR
GRANT
BLACKFORD
JAY
ADAMS
MERCER
DARKE
RIVER
DELAWARE
MADISON
OHIO
INDIANA
N
SCALE IN MILES
NUTRIENT CONTENT OF RURAL RUNOFF
UPPER WABASH RIVER BASIN
INDIANA - OHIO
LOCATION MAP
UNITED STATES DEPARTMENT OF THE INTERIOR
Federal Water Pollution Control Administration

FIGURE 1

A-1

HYDROGRAPH FOR MISSISSINEWA RIVER AT EATON 1966—



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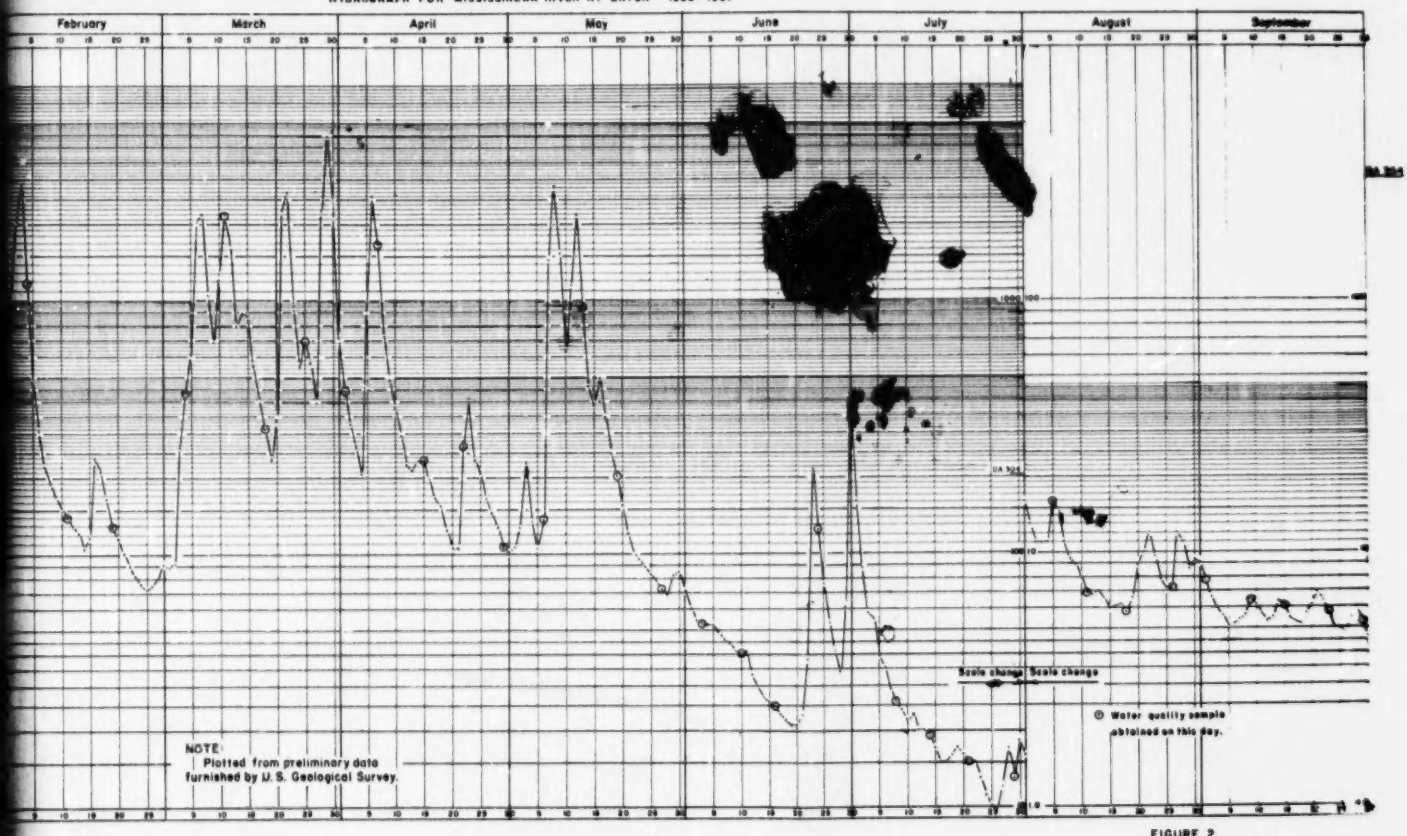
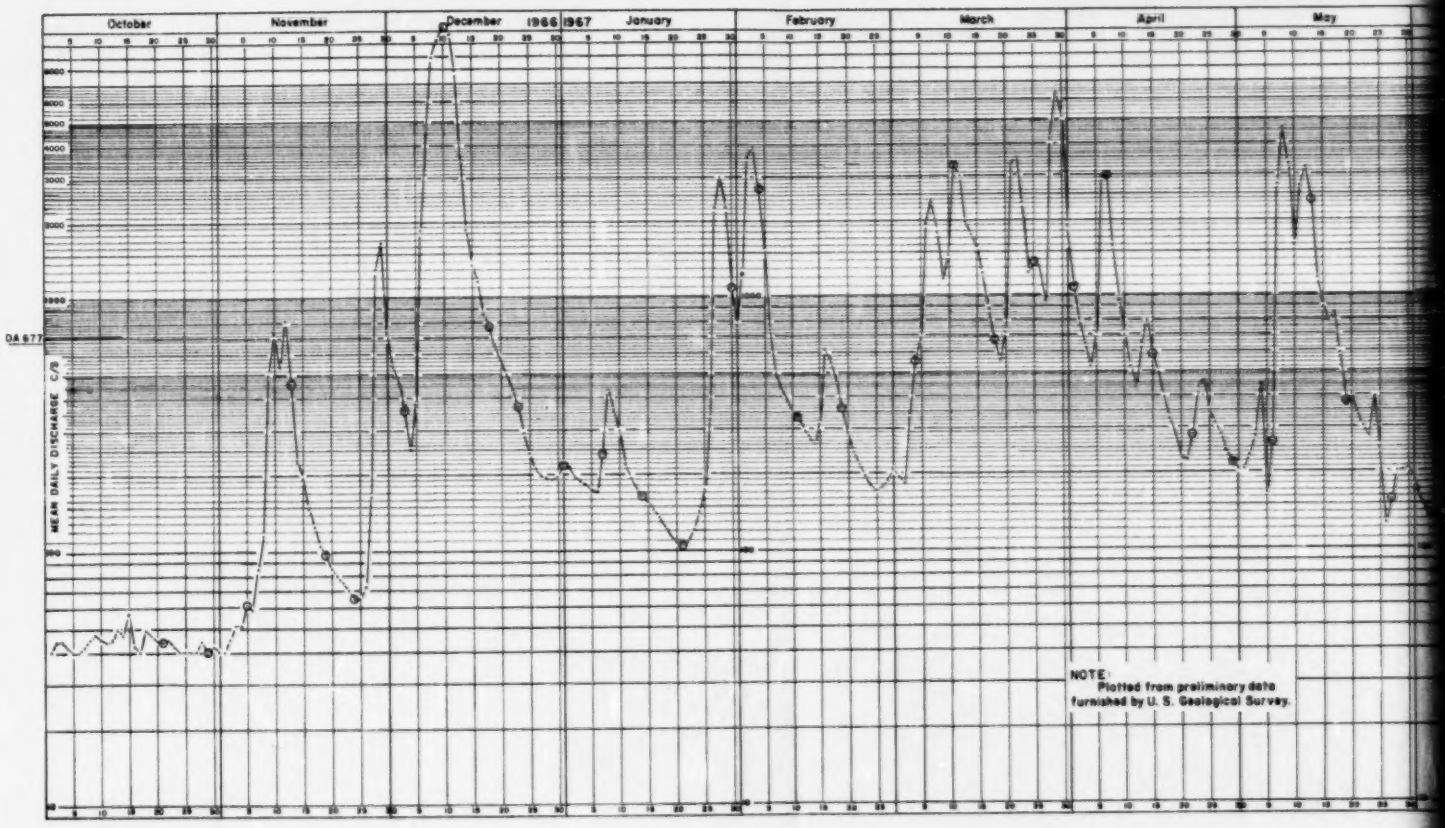


FIGURE 2

A-2

HYDROGRAPH FOR MISSISSINEWA RIVER AT MARION,



HYDROGRAPH FOR MISSISSINEWA RIVER AT MARION, 1966–1967

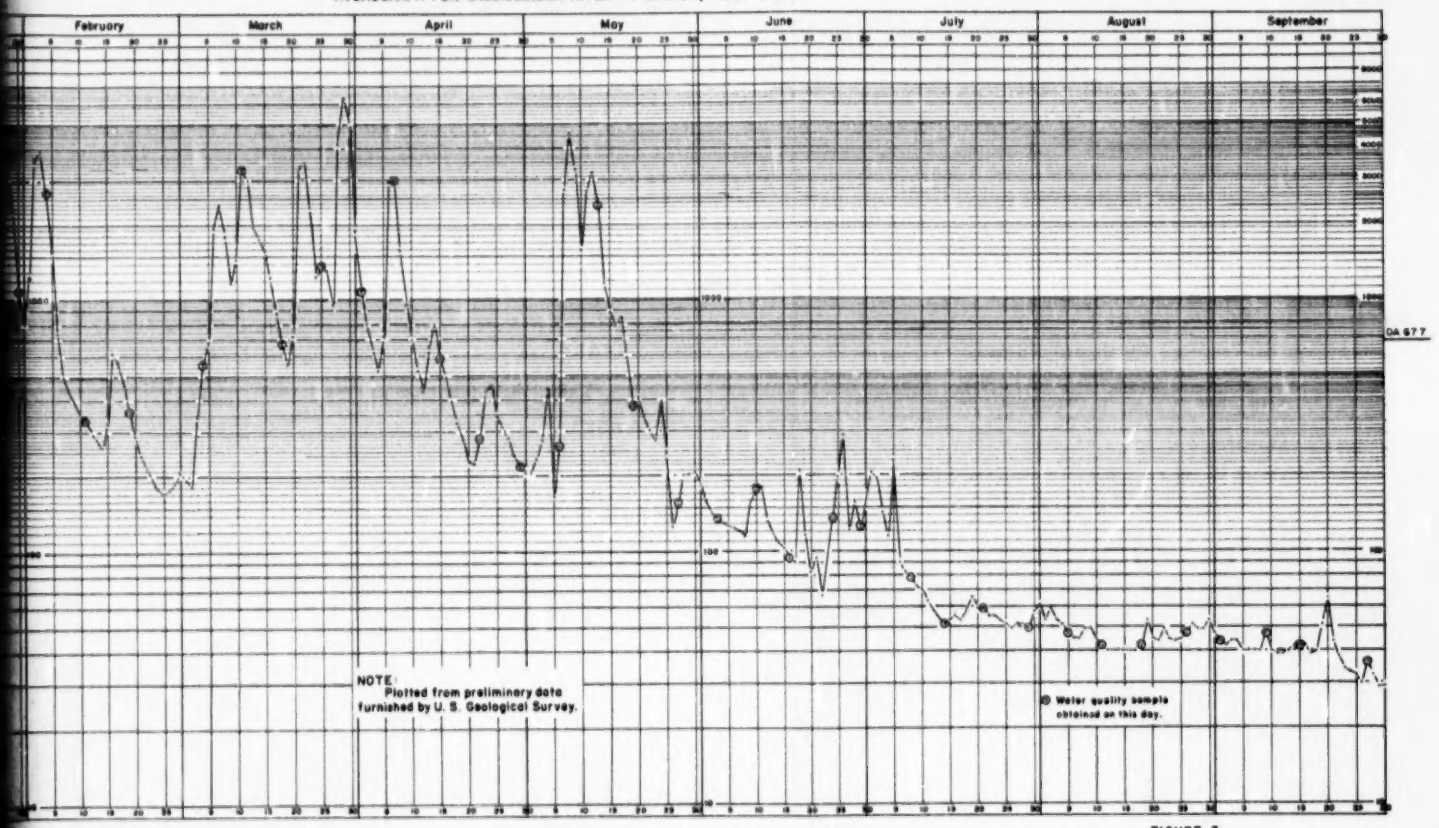
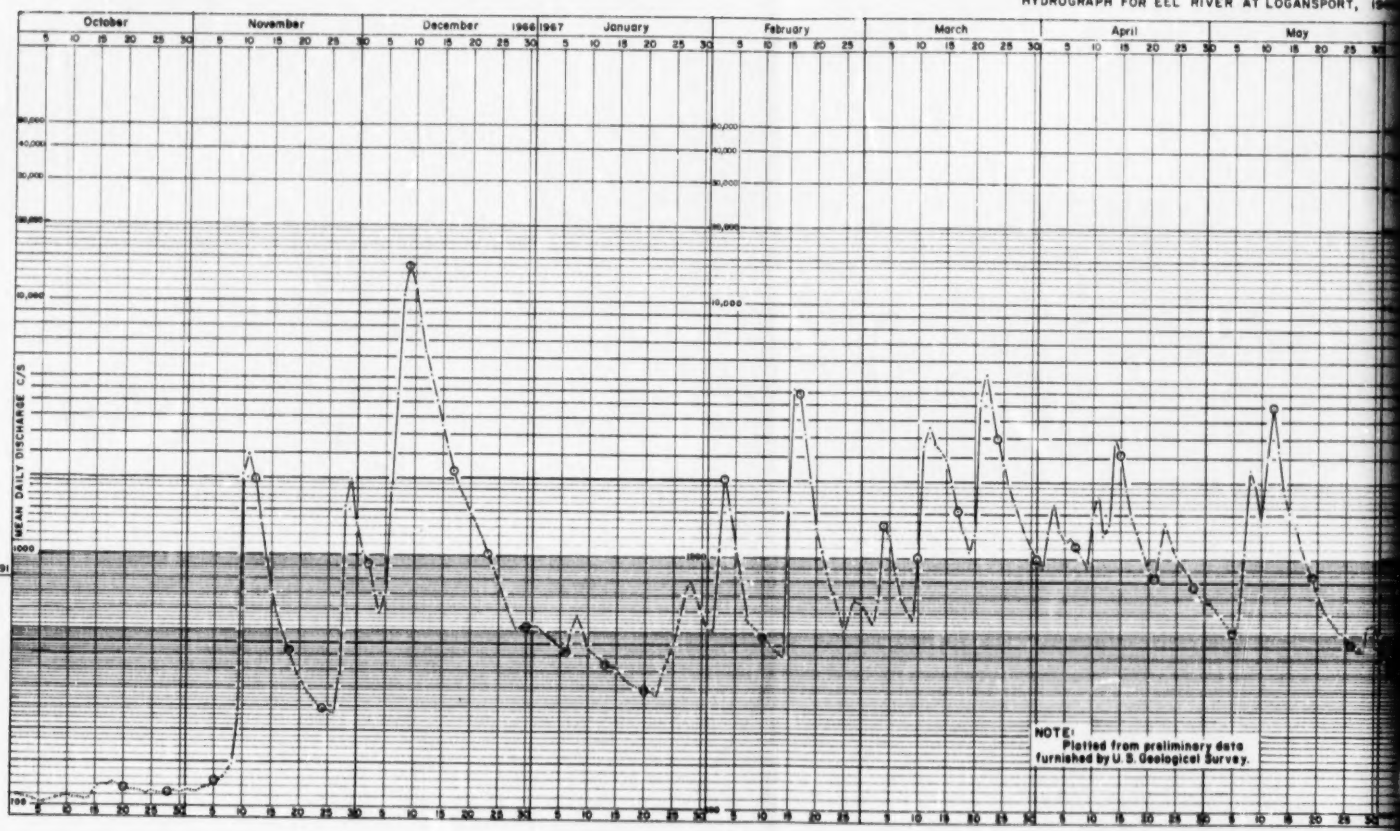


FIGURE 3

HYDROGRAPH FOR EEL RIVER AT LOGANSPORT, 19



HYDROGRAPH FOR EEL RIVER AT LOGANSPORT, 1958-1967

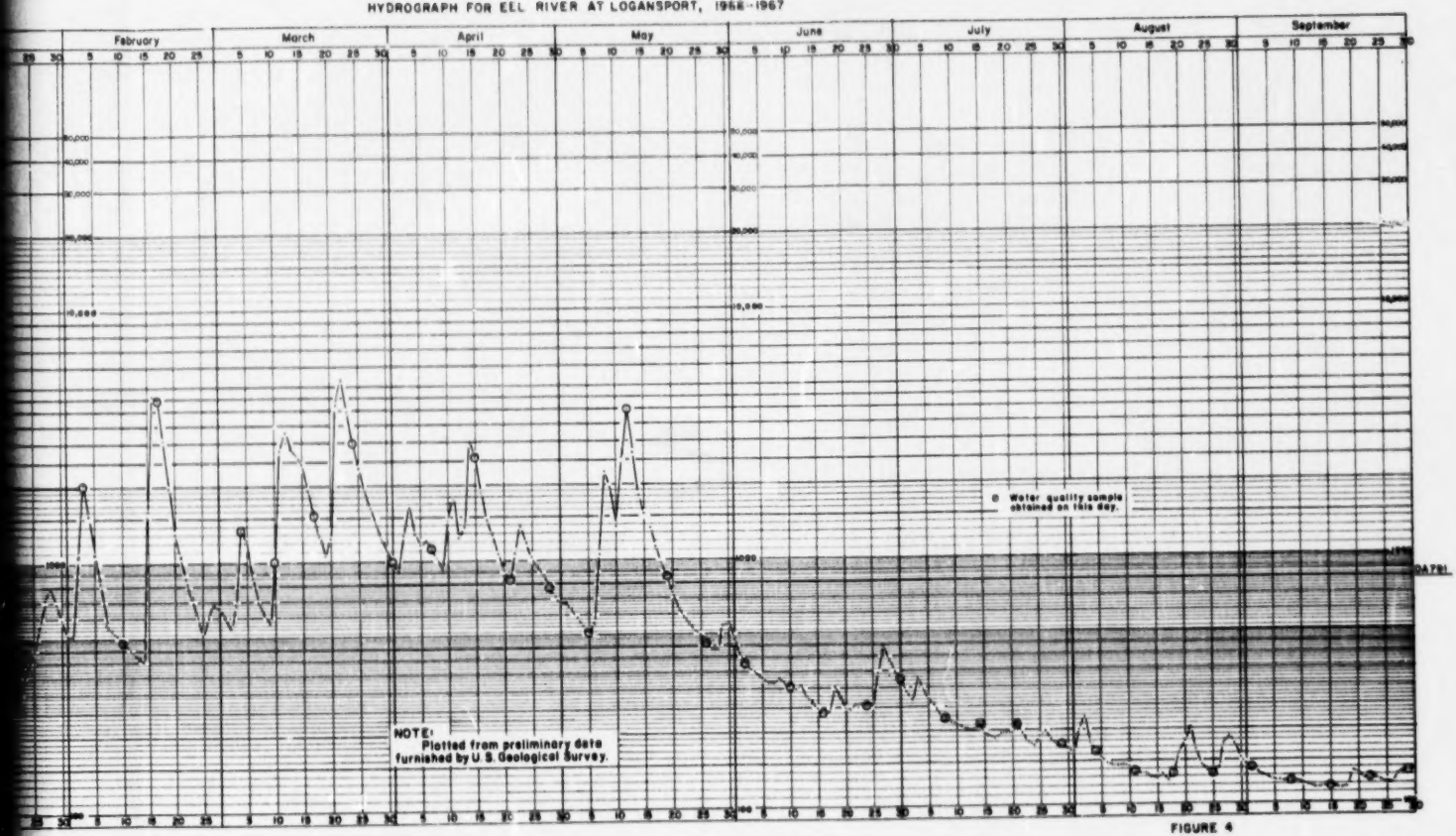


FIGURE 4